

THE D0 ELECTROSTATIC SEPTUM

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So far in this series of reports on the extraction system we have been using an electrostatic septum located in the upstream section of the F0 long straight section, in this report we shall examine the consequences of using the D0 long straight section to house the electrostatic septum. The magnetic septum remains in the A0 straight section as before. The machine lattice around the electrostatic septum has been modified in the manner described in UPC # 14 to include the high beta insert.

The relative phase difference between the D0 and F0 septa is 6.492 ($\nu=19.45$). The fact that this phase difference is almost exactly 180° has several consequences with perhaps the most obvious being that the septum will have a radially inward offset. More importantly though the phase angle of the separatrix stays constant (to within 3°) so that the results of the calculations we have made using the F0 septum on such topics as extraction efficiency, step size, trajectory stability and fast extraction should remain valid for the D0 septum as well. Figures 1 and 2 show a slow extraction separatrix obtained with the septum at F0 and D0. The simillarity of the two cases is evident.

In UPC # 16 we demonstrated the need to keep the maximum amplitude circulating orbits to within ~ 2.0 cms to avoid phase space distortions caused

by the dipole field non-uniformities. During the extraction process the orbit amplitude increases monotonically so that the last turn before the beam is extracted will be the maximum amplitude orbit, the additional kick that this orbit receives from the septum will serve to increase this amplitude further. With the septum positioned at D0 then the kicked particles must travel halfway around the ring before reaching the magnetic septum. It is of primary importance to get an estimate of the maximum allowable amplitude for the extracted beam on this final half turn from the electrostatic to the magnetic septum.

The way that we have chosen to do this is as follows: starting with the electrostatic septum at a large relative offset from the circulating beam we produce very large amplitude extraction orbits and look at the dipole field distortions of the separatrix. We then gradually reduce the septum offset until the distortions become negligible.

Figure 3 shows a $\frac{1}{2}$ integer slow extraction separatrix at the magnetic septum produced by an electrostatic septum at D0 with an offset of 15 mms. Unless otherwise stated all the data presented in this report has been calculated using a 0.05% momentum offset. This value of $\Delta p/p$ is an attempt to account for not only the natural momentum dispersion of the beam but also alignment errors and dipole field excursions from the design values. Figure 4 gives the results of a similar calculation to fig. 3 but using perfect dipole magnets instead of the design fields. Large amplitude extraction orbits (> 3.0 cms last $\frac{1}{2}$ turn) of this type graphically demonstrate the phase space distortion from the higher order dipole harmonics. Figures 5, 6 and 7 show the same separatrix produced for smaller values of septum offset, with the

septum offset reduced to ~ 11 mms then the phase space distortions have been reduced to negligible proportions. The last turn of the maximum amplitude orbit from Fig. 7 is presented in Fig. 8, the average value of the orbit amplitude over the final $\frac{1}{2}$ turn is ~ 24 mms.

The relative trade-off between orbit amplitude on the last $\sim \frac{1}{2}$ turn and septum offset can be improved by removing the extraction elements from the D and E sectors of the ring and increasing the strength of the remaining elements appropriately. This change will not affect the phase angle of the separatrix but will inhibit the growth of the particle radius vector through these two sectors and hence reduce the orbit amplitude on the crucial final $\sim \frac{1}{2}$ turn. These results are demonstrated in Fig. 9 which shows the extraction separatrix at the magnetic septum for an electrostatic septum offset of 13 mms. Comparing these results with the data shown in Fig. 5 we can indeed see a reduction in amplitude. The average amplitude for the last $\frac{1}{2}$ turn has been reduced from ~ 27.5 mms to ~ 25 mms. Referring back to UPC #16 for data relating extraction losses to septum offset then we have that an electrostatic septum offset of 13 mms would give extraction losses of $\sim 1.0\%$.

79/04/12 16:16, 58

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ALPHA 3.02500

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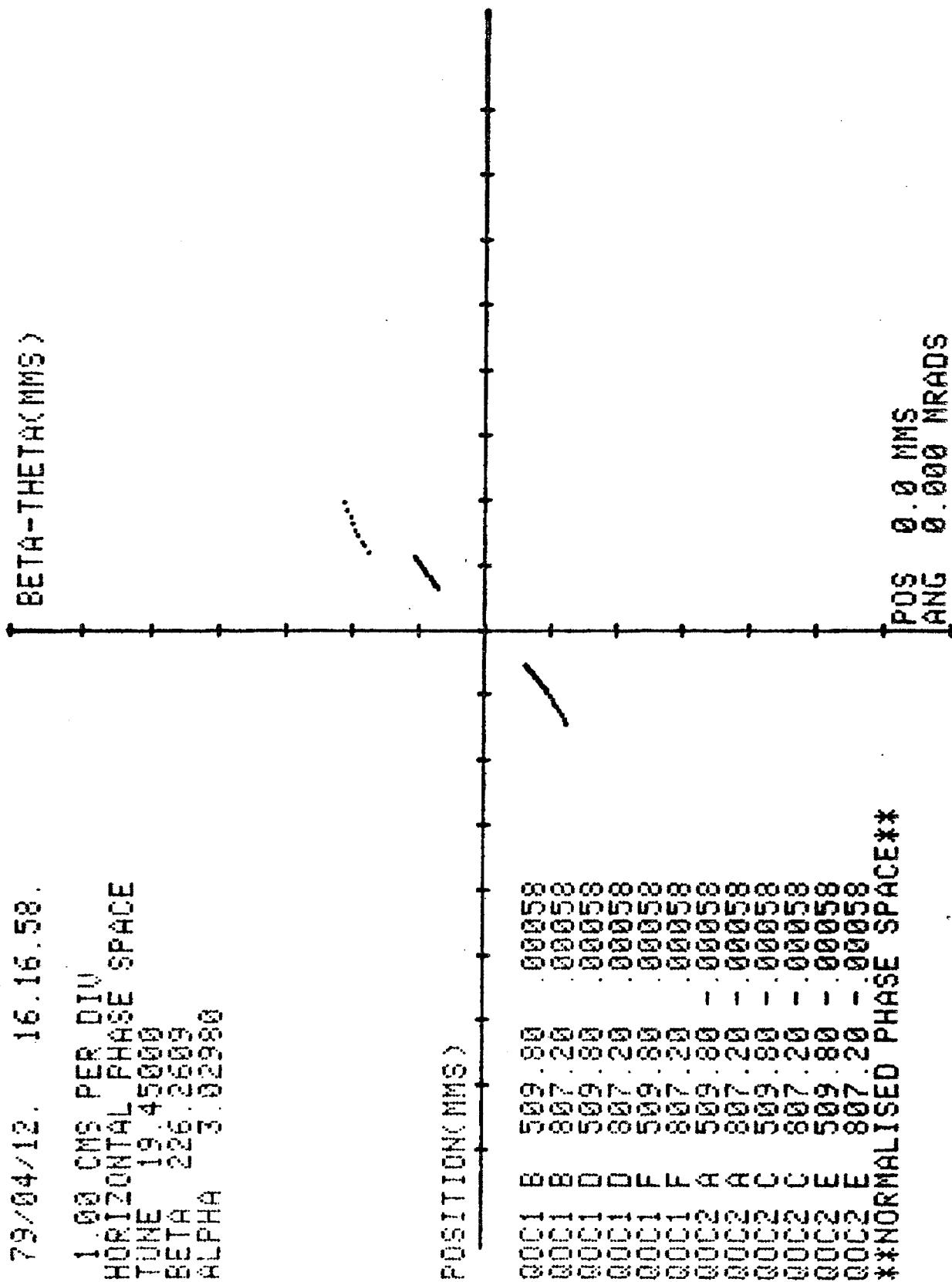


Fig. 1. Slow extraction scparatrix F0 septum. Septum offset 12 mms.

79/04/16. 15.42.53.

BETA-THETA(MMS)

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Q0C1	F	807	20	00000
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Q0C2	A	503	30	00000
Q0C2	A	807	20	00000
Q0C2	C	509	80	00000
Q0C2	C	807	20	00000
NORMALISED PHASE SPACE				

-5-

Fig. 2. Slow extraction separatrix D0' septum. * Septum offset 12 mms.

79/04/14. 09.23.17.

BETÀ - THE TAC(MMS)

1.00 CMS PER DIV
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TUNE 19.45000
BETA 28.33671
ALPHA 2.85180

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Q0C2 E 507 .00058
NORMALISED PHASE SPACE*

-6-

Fig. 3. Slow extraction separatrix D0 septum. $\Delta p/p = 0.05\%$. Septum offset 15 mms. Design magnets.

79/04/16. 16.37.10.

BETA-THETAC(MMS)

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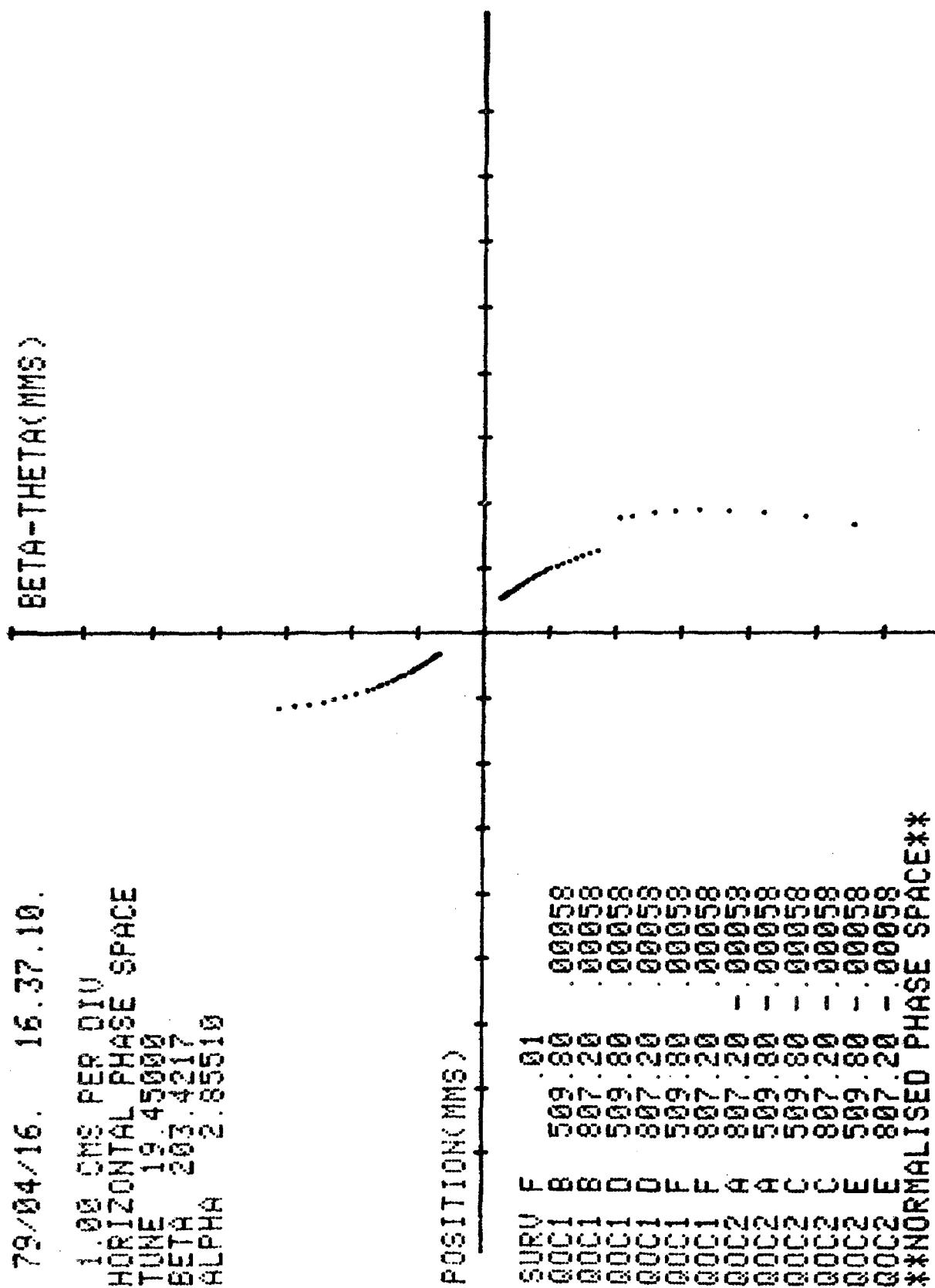
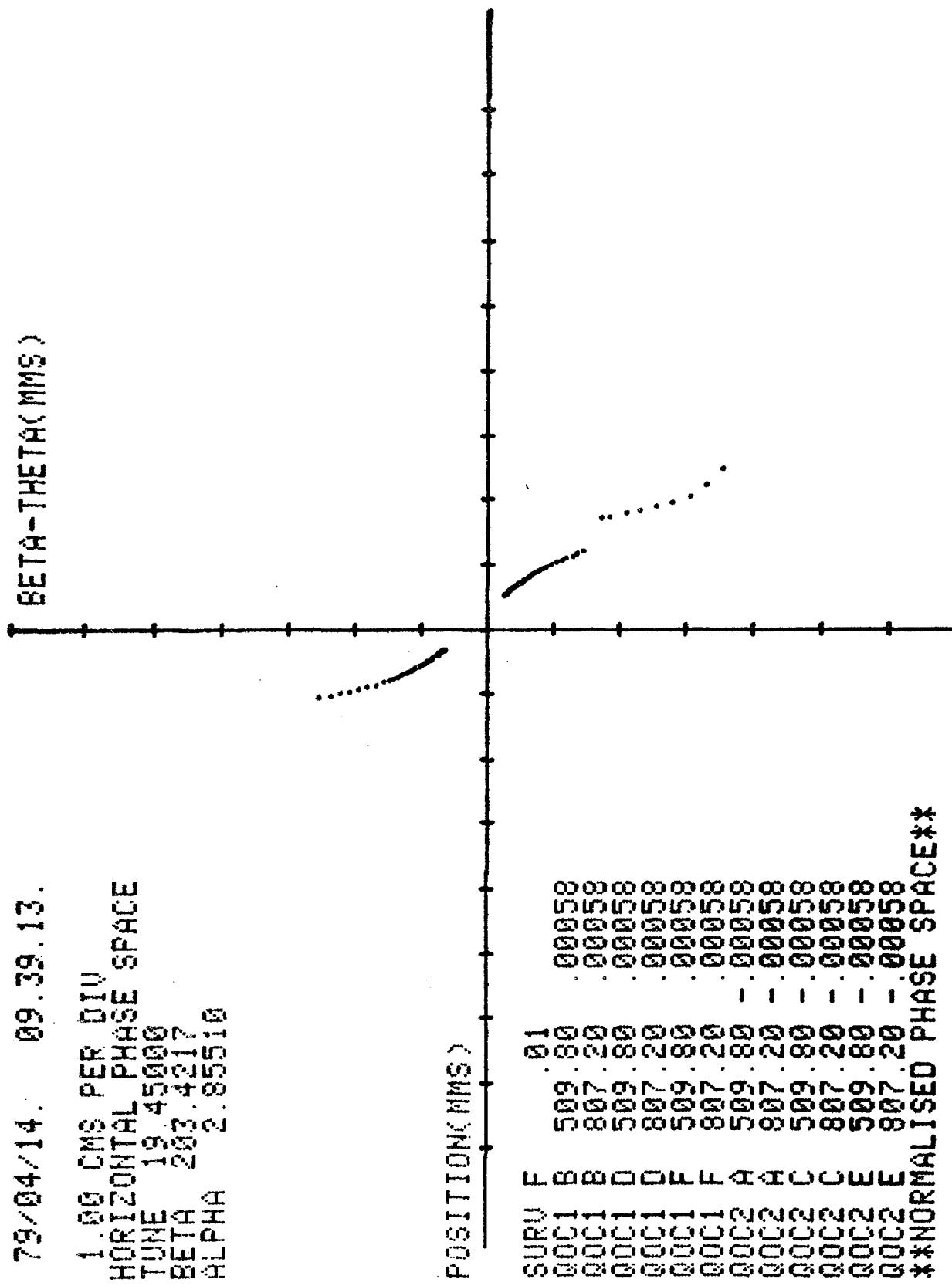


Fig. 4. Slow extraction separatrix. D0 septum. Perfect magnets.
 $\Delta p/p = 0.05 \%$. Septum offset 15 mms.

79/04/14. 09.39.13.

1.66 CMS PER DIV
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 BETA 2.34217
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73/04/14. 09.46.05.

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BETA-THETA(MMS)

-9-

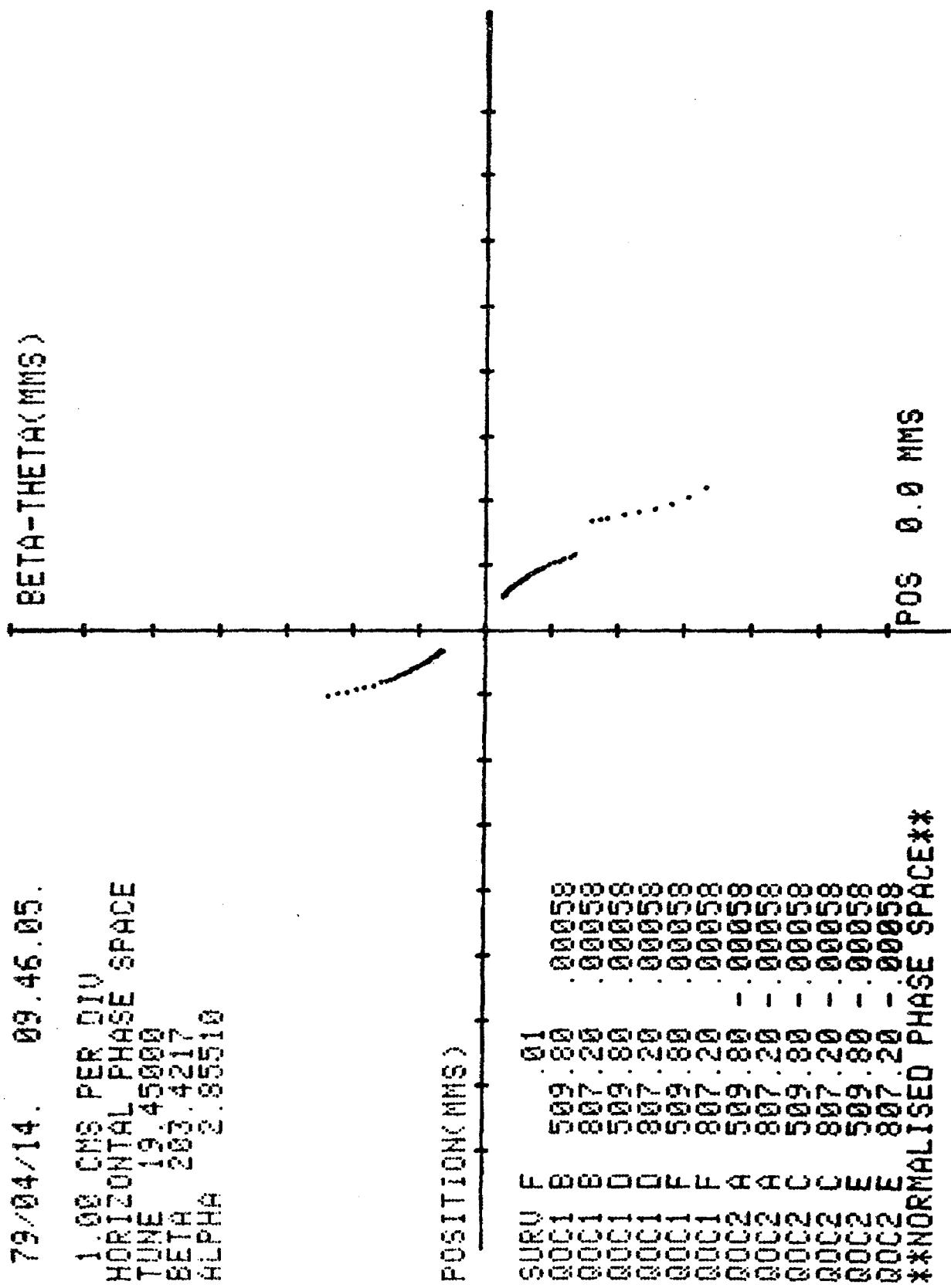
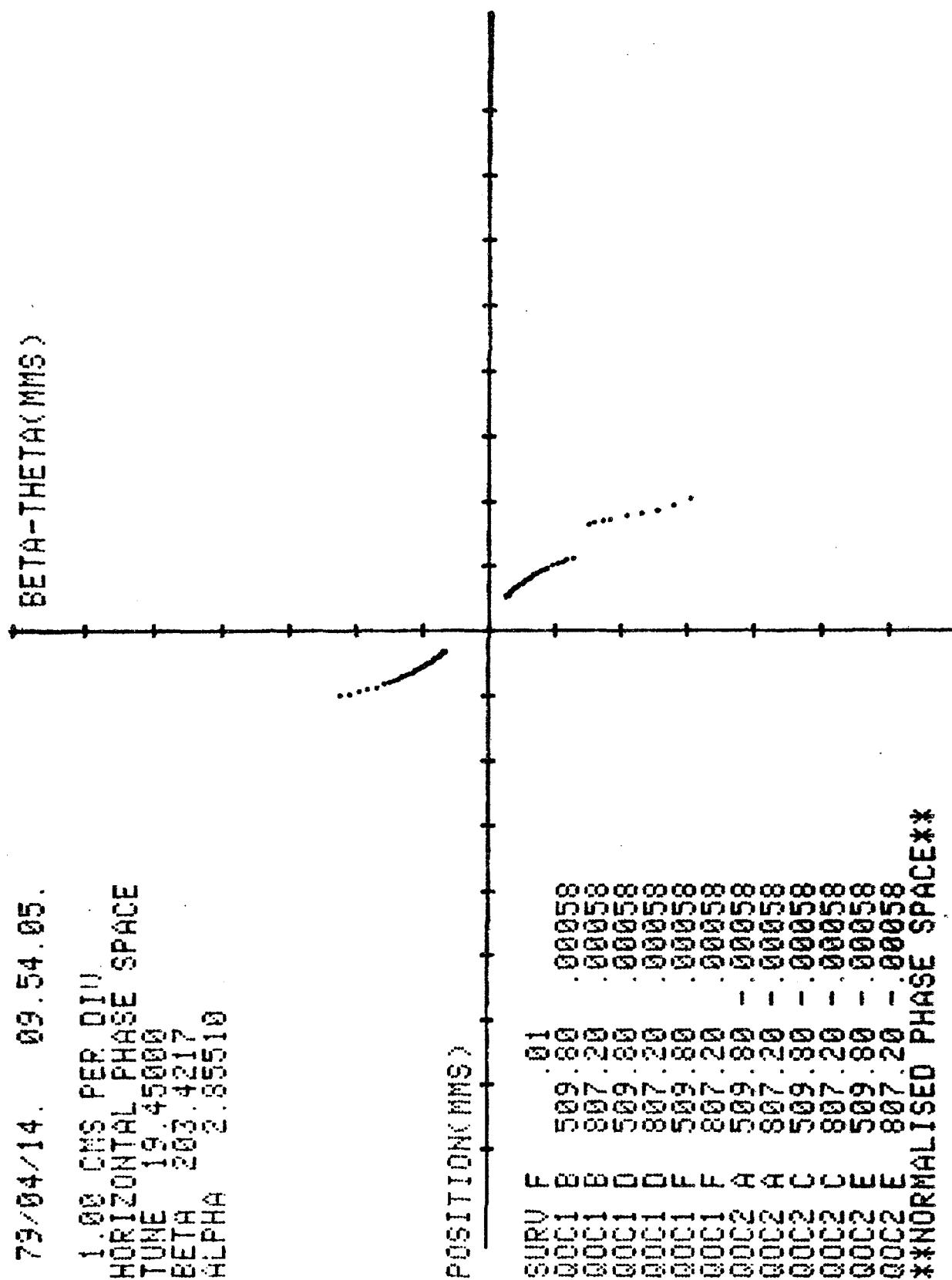


Fig. 6. Slow extraction separatrix. D0 septum. $\Delta p/p = 0.05\%$. Design magnets. Septum offset 12 mms.

79/04/14. 09.54.05.

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BETA-THETAC(MMS)



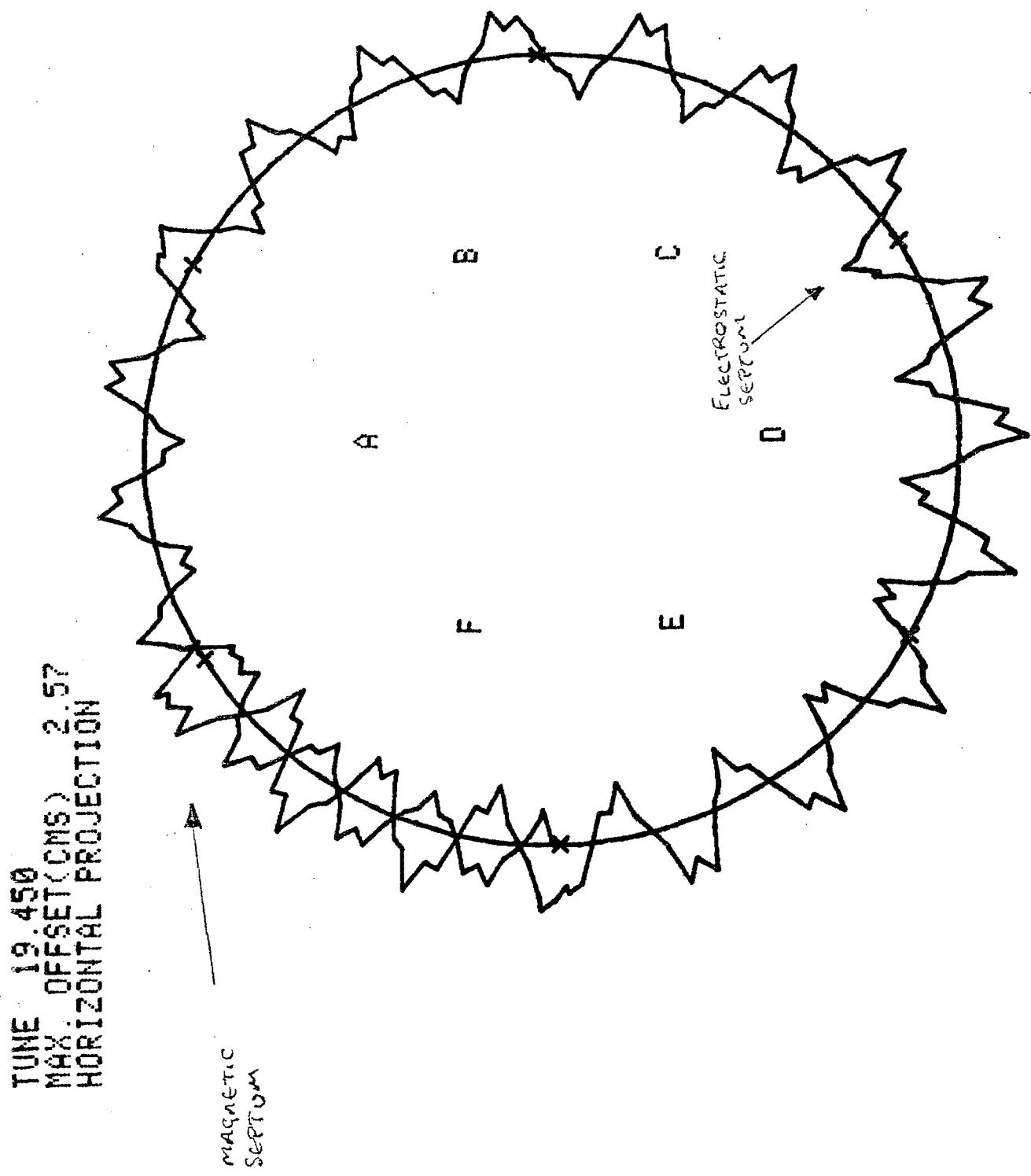


Fig. 8. Last turn maximum amplitude orbit from Fig. 7.

79/04/15. 12.27.17.

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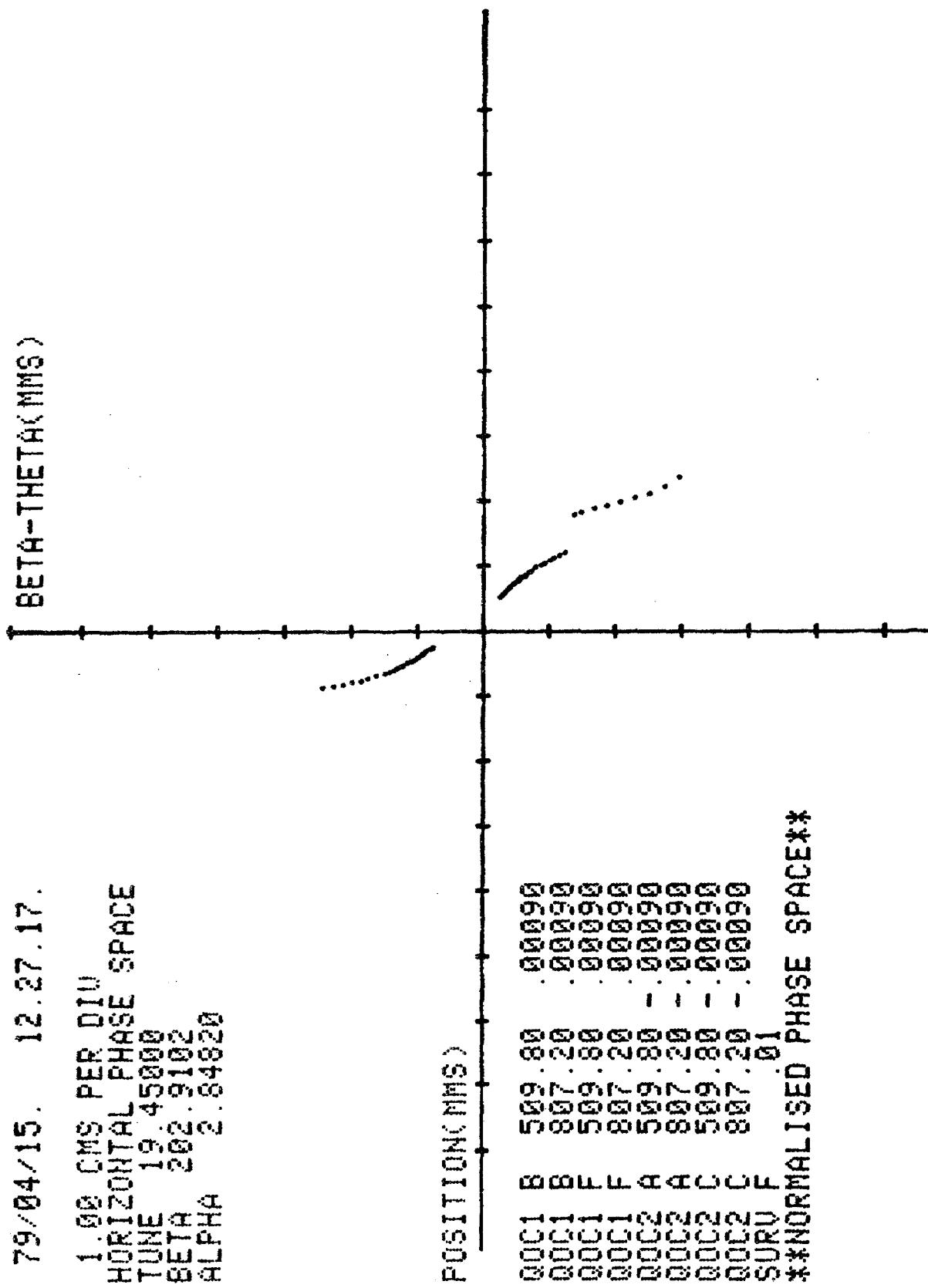


Fig. 9. Slow extraction separatrix. D0 septum. $\Delta p/p = 0.05\%$. Design magnets. Septum offset 13 mms.
Extraction elements removed from D & E sectors.